

## REMARKS/ARGUMENTS

### Remarks concerning the IDS

The Applicant is submitting with this response copies of the non-patent literature references cited in the prior filed IDS that appear to have been not received by the examiner together with the original IDS.

### Response to request for information

The examiner has requested that Applicant provide references to any textbooks, publications, etc., where the coefficient and equations of claims 4 and 6 can be found.

Applicant notes that the *standard* Black-Scholes equation and the coefficient  $r$  are well-known in the art and are described, for example, on Wikipedia at <<[http://en.wikipedia.org/wiki/Black-Scholes#The\\_Black-Scholes\\_PDE](http://en.wikipedia.org/wiki/Black-Scholes#The_Black-Scholes_PDE)>>.

To the best of the Applicant's knowledge, the coefficient  $\mu_e - \beta_{em}(\mu_m - r)$  derived from the stated  $x_m$  and recited in claim 1 is novel. The Applicant is not aware of this coefficient having been described, derived, or suggested in the prior art. Similarly, to the best of the Applicant's knowledge, the *extended* Black-Scholes equation as specifically recited in claim 6 is novel and is not described or derived or suggested in any prior art. Accordingly, Applicant is unable to provide the Office with any such references. However, Applicant directs the examiner's attention to pages 22-24 of the specification which provide a derivation of the *extended* Black-Scholes equation and the recited coefficient from original ideas of the inventor.

### Response to rejections — 35 USC 101

In response to the rejection of the claims under 35 USC 101, the Applicant has amended the claims so that the steps of the claims are explicitly tied to a particular physical apparatus. In addition, that Applicant notes that the process as claimed is limited to a specific practical application. Accordingly, the claims as amended are directed toward statutory subject matter.

### Response to rejections — 35 USC 102 and 103

In response to the rejections of the claims under 35 USC 102 and 103, the Applicant has amended the claims to more clearly distinguish the claimed subject matter. Specifically, claim 1 has been amended to incorporate the limitations of claims 2, 3, and 4. Applicant submits that claim 1, together with the combination of the limitations in claims 2, 3 and 4, is patentable over the cited references. The following remarks provide some background discussion and explains the significant innovative features of the claimed invention.

According to common understanding in modern finance theory, in certain frameworks (such as continuous time models), the value of a derivative asset can be found by using the “market price of risk” associated with the uncertainty driving the asset. For a pure derivative  $x_e$  (where the underlying variable is a traded security) the market price of risk is  $\lambda = (\mu_e - r) / \sigma_e$ , where  $\mu_e$ , and  $\sigma_e$  are the drift rate and volatility of the underlying security and  $r$  is the risk free interest rate. To compute the correct price, the original drift rate  $\mu_e$  is modified to  $\mu_e - \lambda \sigma_e$  (essentially charging a unit price  $\lambda$  for the uncertainty measured by  $\sigma_e$ ). For pure derivatives this results in  $\mu_e$  becoming  $\mu_e - \lambda \sigma_e = r$ . Once this is done, the value of the financial derivative can be calculated as if there were no uncertainty.

In more general situations where  $x_e$  is not a pure derivative, it is common in modern finance theory to assume that there still is some value for the price of risk  $\lambda$ . In many cases this  $\lambda$  is chosen arbitrarily. Some researchers discovered that  $\lambda$  could be expressed more generally as  $\lambda = (\rho / \sigma_m) (\mu_m - r) = \beta (\mu_m - r)$ , where the subscript  $m$  refers to a market representative chosen to be the return  $x_m$  on the entire market, or a close approximation to the entire market, and  $\rho$  is the correlation between the underlying variable  $x_e$  and the market  $x_m$ . This is consistent with the standard Capital Asset Pricing Model of finance which also requires that the representative be the entire market.

To the best of Applicant’s knowledge, no one has suggested that the market representative can be, instead of the entire market, a market asset most correlated with the underlying variable  $x_e$ . This choice depends on the underlying variable  $x_e$  whereas the standard market representative does not change.

There are three advantages to using the most-correlated asset instead of the market asset. First, it is often easier to find the correlation between something close rather than to the market as a whole. For instance, when pricing a new company or a house it is more natural to consider its relation to similar companies or houses rather than to the overall securities market. The second advantage is a technical one. Theoretically, the overall market is only an approximation to the “Markowitz portfolio” which is actually required in theory but does not always exist. The third and most important advantage is that to optimally hedge a derivative of  $x_e$ , one must in fact use a most-correlated asset. This is not treated in the previous methods.

The earliest accounts of using a price of risk  $\lambda$  for evaluation of derivatives goes back to 1979 in a well-known paper by Harrison and Kreps. However, for non-tradable assets it was not clear how to determine the proper  $\lambda$ . A most authoritative reference on derivatives is the text by John Hull. His 2002 5th edition explains that the market price of risk can be estimated as  $\lambda = \beta_{em}(\mu_m - r)/\sigma_e$  where the  $m$  subscripts refer to a broad market representative. There is no mention by Hull of using a most-correlated asset. The Applicant is aware of no use of a most-correlated asset as the market representative, and this is a feature of the main claim of the application, as amended. It is an important discovery, for the reasons stated earlier, and it can be considered non-obvious since it has not been discovered over this long period where many experts have worked on the issue.

The Schwartz paper states that market prices for risk must be assigned to two of the variables in the firm considered in that paper. The paper only vaguely suggests how they might be computed, but since “aggregate wealth” is used it can be inferred that the formula stated by Hull is used. From here, Schwartz carries out the standard approach of evaluation under the assumption that the risk has been accounted for by the  $\lambda$ 's. This explains why so much of Schwartz appears similar to details in the patent application. Schwartz addresses a problem that is of the same type, and Schwartz presents a general idea of a solution that is similar to the approach followed by the present invention. However, Schwartz uses a formula for  $\lambda$  based on the overall market. In contrast, the claimed invention uses an explicit formula based on the most-correlated asset. Schwartz does not teach or suggest the specific and explicit formula recited in the claims of the

present invention. There is no teaching or suggestion in the prior art that would lead someone to the specific claimed formula rather than some other specific formula.

It is worth specifically pointing out that, although Schwartz mentions the importance of the company's industry, it is for the purpose of determining company parameters. In particular, the industry facts are used to estimate  $\mu$  and  $\sigma$ , which are needed to define the model. Significantly, however, Schwartz does not use the industry information to estimate the market value of risk. In contrast, the claimed invention provides an estimate of the market value of risk based on the most-correlated asset.

In addition, it is worth pointing out that Equation (14) of Schwartz is merely a statement that the value depends on the variables of the model. Equation (15) is found by differentiation of Equation (14). It is clear how to differentiate most of the terms since they come from fixed relations. The important terms are  $dR$  and  $d\mu$  which are from Equations (11) and (12). These are based on the price of risk, determined on the basis of a broad market representative, not a most-correlated asset.

The above discussion makes it clear that the claims as amended are neither anticipated by, nor in any way obvious in view of the cited references. Thus, the claims as amended are submitted as patentable over the cited art.

Respectfully submitted,

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